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NRL Memorandum Report 4711

Predicting the Effectiveness of Concepts for Future Marine Corps Medical Support Systems

Preliminary Report

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December 10, 1981

This research was supported in part by the Naval Medical Research and Development Command.



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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER NRL Memorandum Report 4711	2. GOVT ACCESSION NO. RD A108 837	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) PREDICTING THE EFFECTIVENESS OF CONCEPTS FOR FUTURE MARINE CORPS MEDICAL SUPPORT SYSTEMS - Preliminary Report		5. TYPE OF REPORT & PERIOD COVERED Interim report on a continuing NRL problem.	
7. AUTHOR(s) J.R. Fletcher, M.D., Ph.D.* and P.B. Richards, Ph.D.		6. PERFORMING ORG. REPORT NUMBER	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Research Laboratory Washington, DC 20375		8. CONTRACT OR GRANT NUMBER(s)	
11. CONTROLLING OFFICE NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 63706N: B01-26; 71456-7232	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE December 10, 1981	
		13. NUMBER OF PAGES 55	
		15. SECURITY CLASS. (of this report) UNCLASSIFIED	
		16. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES *Present address: Department of Surgery, National Naval Medical Center, Bethesda, MD 20814. This research was supported in part by the Naval Medical Research and Development Command.			
19. KEY WORDS (Continue on reverse side if necessary; and identify by block number) Military medicine Combat casualty medical care Emergency medical services			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is a preliminary attempt to identify options for overcoming delays in providing emergency, life-saving medical care in a mass casualty situation. Faced with the need to predict the effects of possible shortages of key medical personnel, particularly surgeons, and also faced with the possibility that medevac helicopters might be inoperable in combat, the Marine Corps requested the authors to analyze in detail Navy/Marine Corps plans for supporting Marine Corps combat operations in the 1984-1993 time period. The (Continues)			

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S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued)

principal tool used in this study was the Navy's WWMMSS (World-Wide Military Medical Support System) simulation model.

Projected patient loads were approximately 1400 casualties on D-Day, followed by a steady constant influx of about 400 casualties per day, in a conventional warfare environment. The WWMMSS model predicted that with currently planned medical personnel and procedures, more than 8% of all patients admitted to medical facilities following the second day of combat would die. This "steady-state" mortality rate is 2 or 3 times higher than that suffered by the Marine Corps in Vietnam or Korea. The model also predicted that almost 26% of all patients admitted to facilities during the first two days of combat would die. The medical workload was at its peak during this initial two-day period. All of the predicted deaths occurred at Medical Company facilities, where excessive delays in patient handling occurred, particularly in regard to triage, X-rays, and surgical procedures.

Subsequent simulations were conducted to predict the outcomes of different medical support options in order to provide a quantitative basis for decision making. The options analyzed do not exhaust all possibilities; they represent various changes in procedures and/or resources that could be implemented, with varying effectiveness on reducing the high mortality rates.

The principal findings of this preliminary study are:

- The steady-state mortality rate can be reduced to 3% or less.
- The peak load mortality rate can be reduced to 11% or less.
- Key medical personnel are overworked.
- Bed shortages exist.

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Accession #	
UNIT	GR241
FILE	TRM
Accession	
Classification	
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Reviewed by	
Approval Codes	
Level and/or	
Special	
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**PREDICTING THE EFFECTIVENESS OF CONCEPTS FOR
FUTURE MARINE CORPS MEDICAL SUPPORT SYSTEMS**
Preliminary Report

INTRODUCTION

At the request of the U.S. Marine Corps Development and Education Command (MCDEC), the authors have conducted a series of experiments, using the Navy's WMMSS (World-Wide Military Medical Support System) simulation model, to predict the effectiveness of concepts for supporting the Fleet Marine Forces during the 1984-1993 time period. All testing throughout the study was based on the medical treatment and evacuation system shown schematically in Figure 1. The objective of the study was to assess the capability of this configuration, together with its resources and the medical regulating procedures employed, to provide adequate and timely life-saving emergency medical care for the following conventional warfare casualty workload (approximate figures):

D-Day	1200 Inpatients, 150 Outpatients
D+1, etc.	350 Inpatients, 50 Outpatients
Total*	6450 Inpatients, 900 Outpatients

Each casualty was classified in one of seventy-five different surgical or medical categories or classes, according to the nature and severity of his wounds or illness. These classes are described in Appendix A. The proportion of patients in each class is described in Appendix B. The overall patient "mix" was 60% surgical and 40% medical.

MCDEC had already given considerable thought to this particular configuration, but was concerned about two key questions:

1. the possibility that helicopters might not be able to be used; or that there might not be enough of them;
2. there might be a shortage of key medical personnel, particularly at the Medical Company (MEDCO) facilities.

It was primarily because of these questions that MCDEC asked the authors to study this configuration, using the WMMSS model's capability to simulate mass casualty systems in great detail.

*In all cases, simulated combat lasted for 16 days. This period was considered sufficiently long for the medical support system to achieve "steady-state" conditions.
Manuscript submitted October 28, 1981.

BASIC SYSTEM PARAMETERS

Most of the parameters associated with the basic configuration of Figure 1 remained constant throughout the study. All of the inpatients entered the system at the FEBA (Forward Edge of the Battle Area), where there were 30 units, and 10% of the outpatients entered the system there. Each unit at the FEBA was essentially a collecting area where casualties underwent triage and received first aid. Each collecting area had eleven medical corpsmen on duty 24 hours-a-day. Following this initial emergency care, the inpatients were evacuated by 4x4 vehicles to the BAS (Battalion Aid Station) level, which was located one kilometer behind the FEBA level. There were 10 medical facilities at this level, each of which serviced the inpatients from three FEBA units. Each BAS was the base for seven 4x4's. The outpatients at the FEBA were returned to duty once they received treatment at the FEBA.

When the inpatients arrived at the BAS level, they were removed from the 4x4's, received triage, and then proceeded on to one of the 5 Medical Company (MEDCO) units which were located 9 kilometers further to the rear, or else to the Hospital Company (HOSPCO), which was 24 kilometers from the BAS level. Each BAS facility had two medical specialists on duty 24 hours-a-day who performed triage. No other treatment was provided at the BAS level. Some outpatients (25%) entered the system at the BAS level; they also received triage and were then evacuated to the rear. No patients were retained at the BAS level longer than required for triage. The evacuation policy* there was zero, and there were no convalescent beds.

The MEDCO level was the first echelon at which definitive life-saving care, including surgery, could be performed. The types and numbers of medical personnel who were on duty 24 hours-a-day at each MEDCO facility in the baseline case are shown in Table 1. As shown in Figure 1, each MEDCO facility had 60 convalescent beds and a 3-day evacuation policy. Thirty percent of all outpatients entered the system at the MEDCO level.

*The evacuation policy at a facility is the maximum period of time which a patient is allowed to remain at the facility.

Table 1
TABLE OF ORGANIZATION
TREATER DESCRIPTIONS AND ASSIGNMENTS
(BASELINE)

DESCRIPTION	MEDCO	HOSPCO
General Surgeon	2	6
Ward Nurse (Med/Surgical)	0	0
General Medical Practitioner	0	2
Shock and Surgical Corpsman	6	18
Surgical Ward Corpsman	12	48
Physicians Assistant	0	2
Operating Room Technician	12	22
Anesthesiologist	2	4
Oral Surgeon	0	1
Psychiatrist	0	2
Clinical Psychologist	0	2
Nurse Anesthetist	2	4
Laboratory Technician	4	7
Ophthalmologist	0	1
Litter Team (4 men each)	5	5
X-Ray Technician	2	8
Internist	0	3
O.R. Nurse	2	12
Orthopedic Surgeon	2	2
Thoracic Surgeon	0	1
Cast Room Technician	1	4
Neurosurgeon	0	1
Neuropsychiatric Technician	0	10
Cardiopulmonary Technician	0	2
Dermatology Technician	1	2
Pharmacy Technician	2	4
Dental Technician	0	3

The remaining 35% of all outpatients entered the system at the single HOSPCO facility, which was 15 kilometers behind the MEDCO level. The HOSPCO had 240 convalescent beds, a 7-day evacuation policy, and a 24 hours-a-day medical staff as shown in Table 1.

The evacuation vehicles were employed in what was considered to be the most efficient manner from the life-saving point of view. Specifically, the 4x4's, which were based at the BAS facilities, went forward to the FEBA to pick up inpatients and transported them to the BAS units. These vehicles also evacuated patients from the BAS level to the Medical Company level, as shown in Figure 1. Once a 4x4 delivered patients to a BAS facility, it waited there for further instructions. Upon delivering patients to a MEDCO facility, a 4x4 would immediately return to its BAS base to await further assignment. Each MEDCO facility served as the base for 16 ambulances, which evacuated patients from the BAS level to the MEDCO level, and from the MEDCO level to the HOSPCO. Because all the ground vehicles traveled at very slow speed (10 kilometers/hour), it was decided that such vehicles would not be allowed to carry any patients non-stop from the BAS level to the HOSPCO, a trip that would take 144 minutes. Instead, all patients who were evacuated by ground vehicle from the BAS level were unloaded at the MEDCO level, where they received as much treatment as possible. On the other hand, the 150 kilometer/hour helicopters (CH46D's), which could fly from the BAS level to the HOSPCO in 9.6 minutes, always followed the procedure, when leaving the BAS level, of going directly to whichever facility level was the closest echelon at which any passenger (patient) could receive all of his required life-saving medical and surgical treatment. Thus, if a single helicopter evacuee from the BAS could receive his complete treatment at the MEDCO level, the helicopter would discharge that patient at the MEDCO level, pick up any patients waiting there, and fly on to the HOSPCO level, where it would discharge all patients. If there were no patients designated to go to the MEDCO level when the helicopter left the BAS level, it would fly non-stop to the HOSPCO.

Three ambulances (M 886's) were based at the Hospital Company; they augmented the MEDCO-based ambulances for carrying patients from the MEDCO

to the HOSPCO. The CH46D helicopters were housed at a single pool which was located 5 kilometers behind the HOSPCO.

Under heavy patient workloads such as those considered in this study, life-saving considerations require that patients receive medical care and undergo evacuation on a priority basis. In the WMMSS model, each patient's priority status at any time is governed by his medical condition, and it changes as his condition changes. Specifically, if patients have to wait for medical care, they are placed in the treatment queue in the following order. First are those patients awaiting triage; they are ranked according to their survival time (shortest comes first), then their priority (1, 2, 3, 4)* which was assigned upon admission to the medical system, and then on a first-in, first-out basis. The second grouping of patients contains those who have received triage but still have an outstanding Critical Mortality Work Unit (CMWU). In the WMMSS model, such a work unit, usually a surgical procedure, must be accomplished within a specified time or the patient will die. Within this group of patients, the ranking is the same as in the group awaiting triage -- time to death, initial priority, and first-in, first-out. The third group of waiting patients contains those who have received triage and are not in need of a CMWU. These are the patients who either had no CMWU or who had one but have already received it. These patients are ranked according to their initial priority and then on a first-in, first-out basis. In a similar way, patients who have to wait to be evacuated are ranked according to their condition within two groups. The first group contains those with an outstanding CMWU; the second group contains those who either had no CMWU or have already received it.

The WMMSS model also allows considerable flexibility in the employment of medical personnel. For each medical or surgical procedure, or work unit, be it X-ray, surgery, EKG or any treatment specified by the model user, the user may also designate appropriate treaters or medical personnel, listed in preferential order. If the preferred treater is available when a work unit is required by a patient, that treater performs the work unit. Otherwise the next

*Priority 1, "urgent"; priority 2, "immediate"; priority 3, "routine"; priority 4, outpatient.

alternate treater is selected, and so on. If no designated treater for a particular work unit is assigned to a facility, any patient requiring that work unit is evacuated to the rear. On the other hand, if at least one of the designated treaters is assigned to the facility, a patient in need of that work unit waits there for that treater to become available. Appendix C lists 49 procedures or work units administered to patients in the current study, together with the designated treaters which were employed in the baseline simulation, listed in preferred order, together with the time required to perform each work unit. Appendix D displays the same information in a different format; Appendix E shows the work units performed by (assigned to) each treater, and the order in which he is selected to perform them. For example, in the baseline case, each general surgeon is assigned a total of 25 work units; he is first choice for 9 of these, second choice for 6, third choice for 5, fourth choice for 3, and fifth choice for 2.

In the WMMSS model, when a patient completes a work unit, if a treater who can perform the next work unit is assigned to the facility, the following procedure takes place. If the work unit just completed was triage, then regardless of whether the patient has received his critical mortality work unit (CMWU), if his triage treater is the only one of that type available, then the patient enters the treatment queue and takes his place according to his ranking. The newly released treater is then matched with patients waiting in the treatment queue. If this treater is chosen to work on a higher ranking patient than the one who just entered the queue, an attempt is immediately made to match up this new patient in the queue with another available treater who can perform his next work unit. If none is available, the new patient will remain in the queue. If the newly released triage treater is not the only one of that type available, then clearly no patient in the treatment queue can use that type, so an attempt is made to match the patient newly released with an available treater, including the one who just performed his triage. If no available treater can perform his next work unit, the patient will enter the treatment queue.

If, on the other hand, the work unit just completed was not triage, an attempt will be made to match the free patient with an available treater,

including the one who just treated him, provided his CMWU is still outstanding. If the patient does not keep the same treater, that treater will be matched with patients waiting in the queue. If this patient has completed his CMWU, an attempt will be made to match him with an available treater, including the one who just treated him, only if there is more than one treater of that type available. Otherwise the patient will be put in the treatment queue, the free treater will be matched up with waiting patients, and then the free patient will be matched up with available treaters.

This procedure for treating patients assures that designated treaters remain with a patient for post-triage care until he receives his CMWU, as long as those treaters can provide the patient with successive work units. Once this continuity is broken, however, the patient may have to wait, the next time he needs the same treaters. This continuity is automatically broken following triage if there are any patients still waiting for triage.

RESULTS OF BASELINE SIMULATION

The baseline simulation addressed MCDEC concerns head-on:

- o No helicopters were used.
- o The medical personnel assigned to each MEDCO unit and to the HOSPCO were as shown in Table 1.

Other resources and procedures used in the baseline case, and the patient workload, were as described in the preceding sections. Work unit assignments for the baseline simulation were as shown in Appendices C and D.

The baseline simulation produced the following patient dispositions:

Total number of patients	7327
Died	847 (11.6%)
Returned to duty	2747 (37.5%)
Evacuated from combat zone	3733 (50.9%)

This mortality rate is 3 or 4 times higher than that suffered in Vietnam or Korea. All of the deaths occurred at the Medical Company level. Although more deaths occurred on D-Day, when the patient load was at its peak, than on any other day, the daily mortality rate at the MEDCO level remained

too high throughout the entire combat period (Table 2). Clearly the resources and/or procedures used in the baseline case were inadequate.

Many of the results of the baseline simulation pointed out deficiencies, but for the sake of brevity we will highlight in this section key outputs which were indicative of a poor combat medical support system, in addition to the high mortality rate at the MEDCO level throughout the combat period. First, the output data showed that of the 847 patients who died at the MEDCO level, 332 died while undergoing treatment, and 513 died while awaiting treatment, whereas only 2 died while in transit to a MEDCO facility. These latter deaths both occurred on D-Day, when 4x4 vehicles stationed at the BAS level failed to respond immediately to 19% of the evacuation requests from the FEBA, and also failed to respond immediately to 19% of the evacuation requests from BAS facilities. Whenever 4x4's failed to respond immediately to evacuation requests from the BAS level, the ground ambulances stationed at the MEDCO level were always available in sufficient numbers, but their use added an additional 54 minutes to the time required to evacuate a patient from the BAS level to the MEDCO level, since those ambulances had to travel from the MEDCO level to the BAS level and return. A further delay was experienced on D-Day during treatment at the BAS level; 29% of the inpatients had to wait for triage at this level on D-Day. By contrast, no patients at the FEBA had to wait for emergency treatment.

Presumably these delays in treatment at the BAS level and in evacuation from the FEBA to the MEDCO level could have been contributing factors in the high mortality rate at the MEDCO level, especially on D-Day. However, these initial delays essentially disappeared once the patient admission rate reached a constant level, so the reason or reasons for the deaths at the MEDCO level had to be found at that level. Results observed on the 10th day of combat (D+9) were typical of the steady-state operation. No patients at the FEBA had to wait for treatment. Only 2% of FEBA 4x4 evacuation requests were not answered immediately. At the BAS level, 85% of all inpatients' requests for triage were honored immediately, and 98% of requests for 4x4 evacuation were also honored immediately. The other 2% were handled by M886's. On the other hand, delays were the rule, rather than the exception, at the MEDCO level on

Table 2

PATIENT DEATHS AT MEDICAL COMPANY LEVEL

Baseline Simulation

<u>Day of Combat</u>	<u>Number of Patients Admitted*</u>	<u>Number of Deaths</u>
1 (D-Day)	1196	335
2	426	81
3	378	26
4	384	37
5	384	32
6	395	30
7	358	41
8	364	25
9	365	22
10	387	41
11	385	33
12	384	36
13	375	32
14	390	32
15	380	23
16	381	21
17	12	0
18	1	0
19	0	0
Total	6945	847

*The number of patients "admitted" includes inpatients and outpatients.

day 10, when 25 patients died awaiting treatment and 16 died while undergoing treatment. On this day 49 patients were still waiting to receive emergency medical care at midnight at this level, even though only 15 patients were admitted to the whole level between 9 PM and midnight.

Pre-surgical X-rays created one problem. Only two X-ray units were available at each MEDCO facility. Across the whole MEDCO level, 266 patients required this service on day 10, and 111 of them had to wait for an X-ray unit to become available. Two patients died while waiting for X-ray; another 13 died while undergoing X-ray.

Further evidence of the problem at the MEDCO level on day 10 (and other days) was contained in two sets of statistics which were gathered from the simulation output data.

- o General surgeons and orthopedic surgeons were usually not available when requested to perform work units for which they were responsible, either as the preferred treater or as an alternate. See Table 3.
- o General surgeons and orthopedic surgeons worked very long hours. On the average, each general surgeon worked almost 20 hours; 9 of these were spent performing major surgery, 3 were spent performing other work units for which the general surgeon was also the preferred treater, about 1 hour was spent substituting for an orthopedic surgeon, and a total of 7 hours was spent substituting for general medical officers, internists, thoracic surgeons, oral surgeons, and neurosurgeons, none of whom were assigned to the MEDCO level. Each orthopedic surgeon worked 17 hours; 4 of these were spent on orthopedic reductions and the remaining time was spent substituting for a general surgeon or one of the specialists who was not assigned to the level.

In addition to the shortages of key medical personnel and also of X-ray units at the MEDCO level, the baseline simulation also showed that the bed capacities at both the MEDCO level and the HOSPCO level were inadequate to handle the patient loads throughout the combat period. This problem was affected by the evacuation policies, by the casualty pre-evacuation stabilization

Table 3.

Baseline Simulation

Availability of General Surgeons and Orthopedic Surgeons
at Medical Company Level when Required, Combat Day 10

<u>Work Unit</u>	<u>No. of Times Work Unit Required</u>	<u>No. of Times Treater Avail- able when Work Unit Required</u>
Triage	387	70 (18%)
Clamp Ligate	35	6 (17%)
Surgical insert of an intra- cath	11	2 (18%)
Surgical procedure to open an airway and/or endotracheal tube insertion	23	4 (17%)
Seal Sucking Chest Wound	25	4 (16%)
Thorocentesis	21	2 (10%)
Insert Foley Cath.	28	7 (25%)
Debridement (Minor Wounds)	72	18 (25%)
Eye Care including eye surgery, nursing care, etc.	7	0
Consultation	48	11 (23%)
Surgical debridement and stabilization or repair of face, neck or head wounds	25	2 (8%)
Major surgery or debridement	57	7 (12%)
Treatment requiring Internist	48	10 (21%)
Neurological stabilization, debridement/repair	5	0
Thoracic surgery, debridement and stabilization	22	7 (32%)

times, and also by the delays in providing treatment. The next section addresses the latter problem, with emphasis on reducing the high mortality rate.

MORTALITY-REDUCING ALTERNATIVES

In evaluating alternative concepts, the authors varied patient management procedures as well as resources. In the course of this research, a sufficient number of simulations were conducted to enable us to compare, on a quantitative basis, five distinct patient management procedures, using four different combinations of resources with each procedure. The patient management procedures tested were:

Procedure A: Work units assigned to medical personnel (treaters) according to Appendices C and D. (Same as in baseline simulation).

Procedure B: Same work unit assignments as in Procedure A except that the general surgeon and the orthopedic surgeon did not perform eye care or internal medicine.

The objective of this procedure was to lighten the work load of these surgeons at the MEDCO level, keeping in mind that patients in need of such care could not be treated until they reached the HOSPCO.

Procedure C: Same work unit assignments as in Procedure A. Additionally, presurgical X-rays were eliminated for the following eleven classes of patients, who contributed heavily to the total number of deaths recorded throughout the entire combat period in the baseline simulation.

- o Head: Fracture, Comp. Com.
- o Head: Wound, P&P
- o Face: Fracture, Comp. Com., Severe
- o Face: Wound, P&P, Severe
- o Face: Wound, Incised, Lac., Severe
- o Upper Extremities: Wound, P&P, Incised, Severe
- o Lower Extremities: Wound, P&P, Lac., Severe

- o Other Musculoskeletal (requiring Surgery), Compression Fractures (Vertebra), Angulation Fractures (Vertebra) (without cord involvement)
- o Thorax: Wound, P&P, Severe
- o Thorax: Wound, P&P, Heart and Trachea, Severe
- o Abdominal: Wound, P&P, Severe

Procedure C was tested in order to learn whether the practice of omitting X-rays, which has sometimes been done under mass casualty battle conditions, would overcome, at least in part, delays caused by the shortage of X-ray units at the MEDCO facilities and also by the subsequent 25-minute X-ray process itself. Eliminating X-rays would also cut down on additional delays in treating some of these patients because of the manner in which patients are processed, as explained earlier. In the case of X-rays, since the X-ray technician has no other duties except to operate the X-ray equipment, another treater must be located for each patient immediately following X-ray treatment, quite possibly with a delay. This discontinuity is often eliminated when X-ray treatment is omitted, since the same treater can perform the work units which immediately precede and follow X-ray. For example, in the case of the second patient class above (Head: Wound, P&P), a surgeon would open the patient's airway, following which the patient would, normally, be X-rayed. If this surgeon was called to attend another patient during this time, another surgeon would have to be sought to perform surgery when the first patient left X-ray. Eliminating X-ray would have avoided this discontinuity and any associated delay in finding the second surgeon.

Procedure D: Same work unit assignments as in Procedure B. Additionally, presurgical X-rays were eliminated as in Procedure C.

Procedure E: Work units assigned to treaters according to Appendices E and F.

The objective of modifying treater assignments as shown in these Appendices, both of which contain the same information but display it differently, was to relieve the work load of the general surgeons and orthopedic surgeons at the MEDCO level. These changes reduced the number of work units assigned to the general surgeon from 25 to 13; and for the orthopedic surgeon from 18 to 13. At the same time the shock and surgical corpsman assumed responsibility for 8 additional work units, and the surgical ward corpsman was assigned 9 additional work units.

Each of these procedures was tested under conditions which were identical to the baseline case except for the number of helicopters that were used and the numbers of general surgeons and orthopedic surgeons at each MEDCO facility. Including the baseline case, 20 different simulations were studied - each of the five procedures was tested under each of the following four conditions:

- Condition 1: No helicopters;
 - 2 general surgeons at each MEDCO facility;
 - 2 orthopedic surgeons at each MEDCO facility.
- Condition 2: 4 helicopters;
 - 2 general surgeons at each MEDCO facility;
 - 2 orthopedic surgeons at each MEDCO facility.
- Condition 3: No helicopters;
 - 3 general surgeons at each MEDCO facility;
 - 3 orthopedic surgeons at each MEDCO facility.
- Condition 4: 4 helicopters;
 - 3 general surgeons at each MEDCO facility;
 - 3 orthopedic surgeons at each MEDCO facility.

Examination of the daily patient dispositions in these simulations showed a consistent peak in patient admissions and deaths at the MEDCO level during the first two days of combat, as in the baseline case (Table 2), following which the daily admissions and deaths remained fairly constant at a lower level. For this reason we decided to compare the 20 simulations on the basis

of mortality rates which would more nearly reflect the effectiveness of the various medical support systems under steady state operations as well as under peak load operations than would a mortality rate based on total admissions and deaths throughout the entire combat period. We therefore measured two mortality rates for each simulation:

- 1) the "steady-state mortality rate" at the MEDCO level, computed from the total number of patients who died following the second day of combat and the total number of admissions during the same period, and
- 2) the "peak load mortality rate" at the MEDCO level, computed from the total number of patients who died during the first two days of combat and the total number of admissions during those two days.

In the baseline simulation, for example, the mortality rate at the MEDCO level based on total admissions and deaths during the whole combat period was 12.2%. More informative results were obtained from the steady-state mortality rate of 8.1% and the peak load mortality rate of 25.6%.

The variation in the steady-state mortality rate at the MEDCO level due to changes in the procedures and resources which were examined is shown in Figure 2. The four points which show changes with varying resources for a given procedure are connected for the sake of clarity. The baseline case is at the top left. Certain tentative conclusions can be drawn from Figure 2 regarding the steady-state medical support operation at the MEDCO level:

- Even with 4 helicopters being used, 2 general surgeons and 2 orthopedic surgeons on duty 24 hours-a-day did not reduce the steady-state mortality rate as low as 3% (Vietnam/Korea figures) when using the treater assignments of Appendix D, unless X-rays were omitted for some patients.
- Omitting X-rays for certain patients was very effective in reducing mortalities, more so than removing responsibility for eye care and internal medicine from the general and orthopedic surgeons.

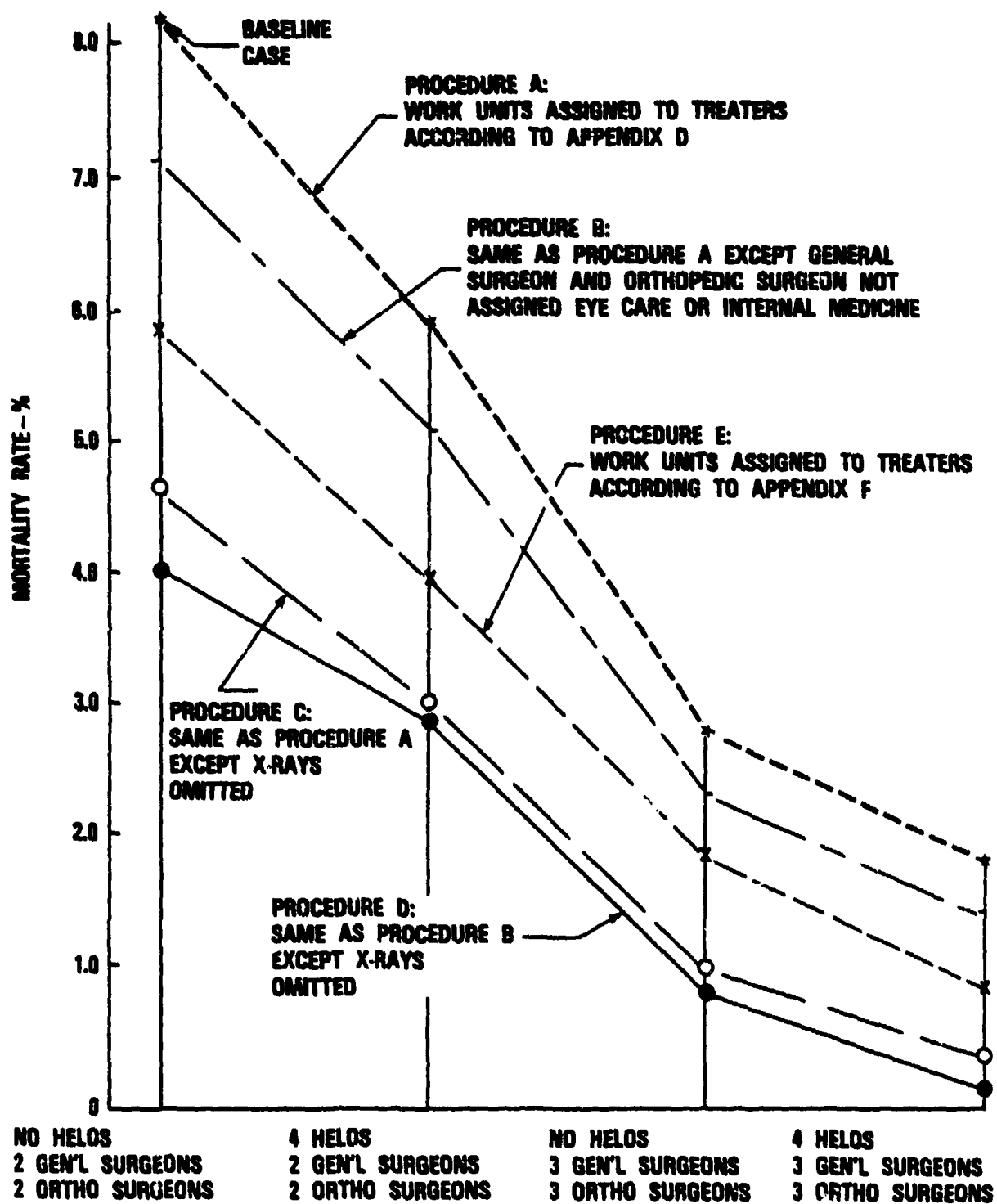


Fig. 2 — Variation in steady-state mortality rate at medical company level due to changes in resources and procedures

- Helicopters had a dual effect. They not only reduced patient delays in reaching MEDCO facilities, but they also carried some patients to the HOSPCO in lieu of MEDCO facility, thereby reducing the MEDCO work load. This is probably why the increase in the numbers of general surgeons and orthopedic surgeons at each MEDCO facility from two to three had less effect on the mortality rate when four helicopters were operational than when no helicopters were used. Stated another way, decreasing the numbers of general and orthopedic surgeons at each MEDCO facility from three each to two caused a smaller rise in the mortality rate when four helicopters were used than none. Additional tests could determine the full extent of increasing the number of helicopters, in conjunction with deliberately bypassing the MEDCO level with more patients.
- As the number of surgeons increased, the effect of increasing the number of helicopters became less. This conclusion, which is different than the preceding conclusion, but not inconsistent with it, suggests that a complete lack of operational helicopters might be overcome by augmenting the MEDCO surgical staff even more.
- The modification of treater assignments, tested in Procedure E, offered considerable promise, bearing in mind that in this procedure, X-rays were not omitted for any patients who would normally receive them. The general surgeons and orthopedic surgeons also performed internal medical care in Procedure E. Considering the effect that the omission of X-rays had on Procedures A and B, we suspect that the Procedure E mortality rates would drop appreciably if that procedure was modified in a similar way. This has not been tested. Further modification of treater assignments would also be worth testing, even without omitting X-rays, in concert with other work load-reducing practices, such as eliminating internal medicine from the surgeon's responsibilities.

The variation in the peak load mortality rate at the MEDCO level due to changes in the procedures and resources which were examined is shown in Figure 3. As in Figure 2, we have connected the four data points which show the variation in mortality rate for a given procedure. The baseline case is identified on the left next to the top. Conclusions drawn from this figure regarding the peak load medical support operation at the MEDCO level are:

- o Unlike the steady-state situation, omitting X-rays for certain patients was not effective until the numbers of general surgeons and orthopedic surgeons at each facility were increased from two to three each. Omitting X-rays is a procedure that reduces delays in presurgical care, as described earlier. It does not lighten the surgeons' work load; it could, in fact, make the surgeons' load heavier by 1) speeding up the presurgical processing of patients, and/or 2) causing fewer patients to die while awaiting or undergoing X-ray. This could account for the detrimental effect of omitting X-rays when using Procedure A with only two general surgeons and two orthopedic surgeons at each MEDCO facility and with no helicopters. Increasing the number of helicopters reduced delays and also lightened the surgeons' load by taking some patients on to the HOSPCO in lieu of a MEDCO facility; this improved the situation. The surgeons' load was also lightened when they were not required to perform eye care or internal medicine; this further improved the situation. Additional testing in which X-rays are omitted should consider carefully the selection of patient classes whose X-rays will be omitted, e.g., should X-rays be omitted for all classes during the peak period, or just from selected classes as was done in this study.
- o Reducing the work load of the surgeons had a significant effect on lowering the mortality rate, whether the load was reduced by increasing resources or by changing procedures.
- o As in the steady-state operation, Procedure E showed considerable potential, which would merit further testing using additional measures to lighten the surgeons' load and reduce delays, such as relieving the surgeons from performing internal medicine and omitting X-rays for some patients.

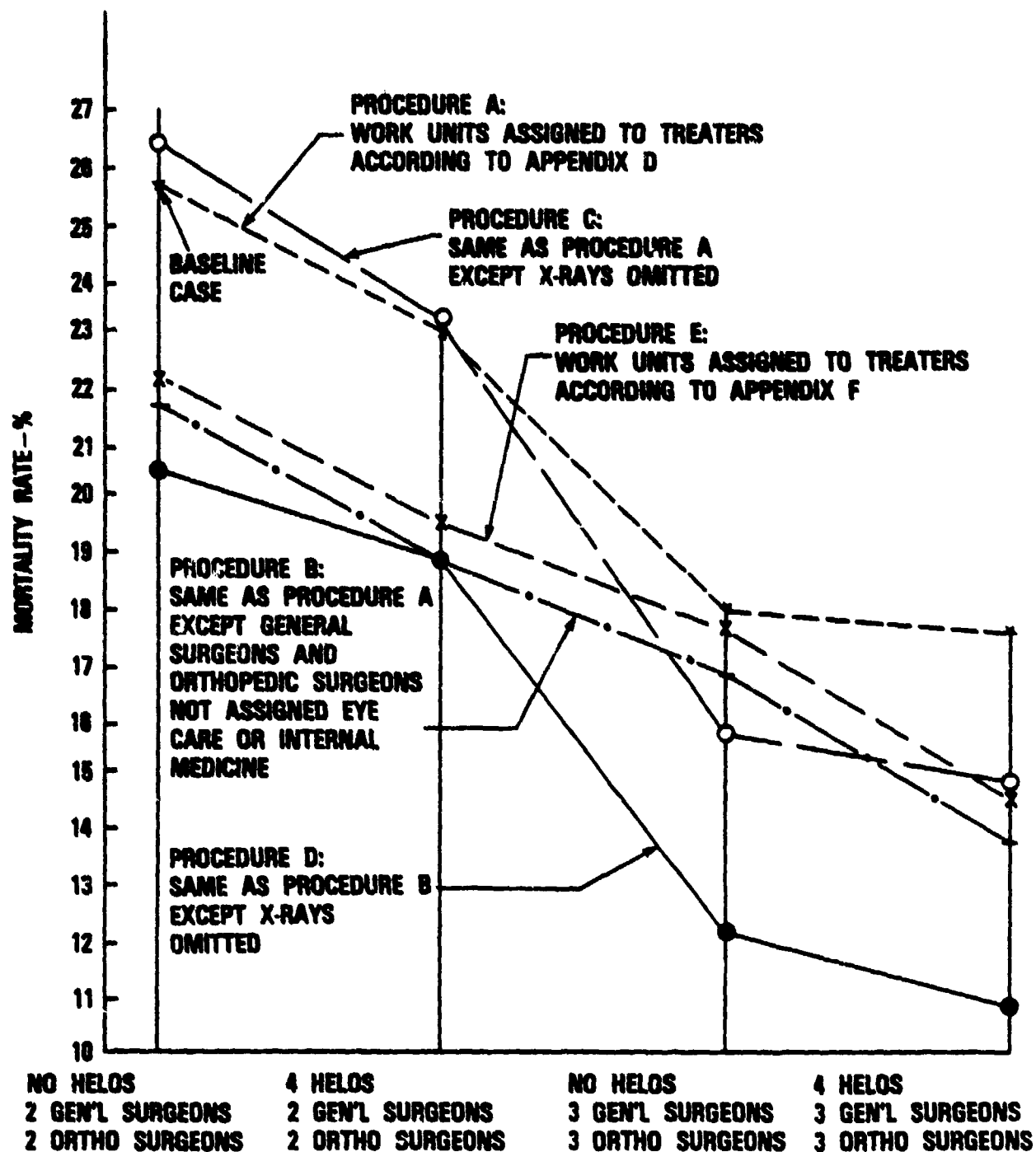


Fig. 3 — Variation in peak load mortality rate at medical company level due to changes in resources and procedures

- Increasing the number of general surgeons and orthopedic surgeons at each MEDCO facility from 2 each to 3 was much more effective than increasing the number of helicopters from 0 to 4. More testing could determine the value of additional staffing during the peak load period in order to reduce the mortality rate further.

A limited number of additional simulations were also conducted to explore the effectiveness of increasing the number of X-ray units at each MEDCO facility. When 4 helicopters were used in conjunction with Procedure A, increasing the number of X-ray units (and X-ray technicians) at each MEDCO facility from 2 to 3, or even to 4, appeared to have slight effect on either the steady-state mortality rate or the peak load mortality rate. During peak load periods, the increase in the number of X-ray units did not appear to reduce delays in receiving X-rays very much. In the best of cases, 70% of MEDCO patients had to wait for such treatment. There were fewer delays in receiving X-rays during the steady-state period when more units were used but that improvement was apparently negated by subsequent delays prior to receiving surgery. The addition of X-ray units should be tested further in conjunction with other procedures, particularly Procedure E.

CONCLUSIONS AND RECOMMENDATIONS

The simulations which have been conducted have indicated that the steady-state mortality rate at the MEDCO level could be held below 3% through the judicious selection of work unit assignments for medical personnel in conjunction with other delay-reducing procedures, such as the use of helicopters and the omission of presurgical X-rays when appropriate. The work unit assignments which were most effective in lowering the mortality rate (Procedure E) also resulted in a more even distribution of daily working hours amongst the medical personnel throughout the combat period, both at the MEDCO facilities and at the HOSPCO. Further refinement of the work unit assignments would be worthwhile in order to see if that would lower the mortality rate further and also further reduce the daily working hours of the surgeons at all of these facilities. Consideration should also be given to transferring

some medical personnel from the HOSPCO to the MEDCO facilities to assist the MEDCO staff. This would further reduce mortalities and also provide more relief for the MEDCO surgeons. Simulations already conducted suggest ways to do this; they can be easily tested.

To limit the peak load mortality rate to less than 10% will definitely require careful selection of medical personnel assignments, the omission or speeding-up of X-rays for many patients, and the temporary addition of personnel at the MEDCO level during this peak period. Possibilities that should be investigated include the reassignment of some shock and surgical corpsmen and some surgical ward corpsmen from the HOSPCO to the MEDCO level for the entire combat period. Additional personnel transfers from the HOSPCO to the MEDCO level might help, but their timing should be tested because in past simulations the key personnel at the HOSPCO were very busy on D-Day; their loads dropped sharply thereafter except for the thoracic surgeon, who generally worked 10 hours a day even during the steady-state phase.

In summary, results of this study suggest that the solution of the Marine Corps medical support problem lies in procedures, as well as in logistics. Work unit assignments to medical personnel are extremely important, as are additional delay-reducing procedures, such as omitting X-rays.

APPENDIX A
Patient Class Descriptions

PATIENT CLASS DESCRIPTIONS

<u>PATIENT CLASS</u>	<u>DESCRIPTION</u>
1	Head: Fracture, Comp. Com.
2	Head: Fracture, Simple
3	Head: Wound, P&P
4	Head: Wound, Incised
5	Head: Concussion, Severe
6	Head: Concussion, Mild
7	Face: Fracture, Comp. Com., Severe
8	Face: Fracture, Comp. Com., Mild
9	Face: Fracture, Simple
10	Face: Wound, P&P, Severe
11	Face: Wound, P&P, Mild
12	Face: Wound, Incised, Lac, Severe
13	Face: Wound, Incised, Lac, Mild
14	Eye (and Orbit): Other Trauma, Severe
15	Eye (and Orbit): Other Trauma, Mild
16	Neck: Wound, Incised and Lac, Severe
17	Neck: Wound, Incised and Lac, Mild
18	Eye: Inflammatory Diseases
19	Eye: Other Eye Diseases (Refractions & Tests)
20	Ear: Inflammation
21	Dental Diseases and Conditions

PATIENT CLASS DESCRIPTIONS

<u>PATIENT CLASS</u>	<u>DESCRIPTION</u>
22	Upper Extremities, Fracture, Comp. Com., Severe, to Include: Crushing and/or Compression Injuries and/or Partial or Traumatic Amputations
23	Upper Extremities, Fracture, Comp. Com., Mild, to Include: Crushing and/or Compression Injuries and/or Partial or Traumatic Amputations
24	Upper Extremities: Fracture, Simple
25	Upper Extremities, Wound, P&P Incised, Severe
26	Upper Extremities, Wound, P&P Incised, Mild
27	Lower Extremities, Fracture, Comp. Com., Severe to Include: Pelvic Fractures and Fractures of the Hip; Crushing and/or Compression Injuries; Partial or Traumatic Amputations
28	Lower Extremities, Fracture, Comp. Com, Mild to Include: Pelvic Fractures and Fractures of the Hip; Crushing and/or Compression Injuries; Partial or Traumatic Amputations
29	Lower Extremities, Fracture, Simple, Severe, to Include: Fracture in Front of Pelvis
30	Lower Extremities, Fracture, Simple, Mild, to Include: Fracture in Front of Pelvis
31	Lower Extremities, Wound, P&P, Lac, Severe
32	Lower Extremities, Wound, P&P, Lac, Mild
33	Other Musculoskeletal (Requiring Surgery), Compression Fractures (Vertebra), Angulation Fractures (Vertebra) (without cord involvement)
34	Osteomyelitis
35	Diseases of Bones and Joints to Include: Arthritis, Rheumatoid Arthritis, Osteoarthritis, Bone Tumors (no surgery required)
36	Thorax: Wound, P&P, Severe
37	Thorax: Wound, P&P, Mild

PATIENT CLASS DESCRIPTIONS

<u>PATIENT CLASS</u>	<u>DESCRIPTION</u>
38	Thorax: Wound, P&P, Heart and Trachea, Severe
39	Abdominal, Wound, P&P, Severe
40	Abdominal, Wound, P&P, Mild
41	Pilonidal Cysts and Sinuses (surgery required)
42	Varicose Veins (Hemorrhoids)
43	Emergency Surgical Conditions (Nontraumatic) to Include: Appendicitis, Hernia, Gall Bladders
44	Ulcer (Bleeding or Obstructing)
45	Burns: 1° - 2° - 3°
46	Lacerations and Contusions to Include: Lacerations, NEC; Contusions, Abrasions, Hematomas; Foreign Bodies, and Puncture Wounds, Mild, Not Elsewhere Covered
47	Wounds/Injuries of Genito-Urinary System
48	Diseases of the Urinary System to Include: Renal Calculus, Hematuria
49	Neurosurgical Conditions (Nontraumatic) to Include: Brain Tumors; Brain Abscesses; Increased Intracranial Pressure; Aneurysms of Blood Vessels of Brain, and Hyperthermia
50	Spinal Injuries to Include: Cord Compression, Herniated Intervertebral Disk, and Tumors, and Cord Involvement
51	Tuberculosis and body areas affected by Tubercule Bacilli
52	Allergies to Include: Allergic Reactions; Urticaria (Hives); Angioneurotic Edema, and Allergic Rhinitis (Hay Fever)
53	Diseases of Skin and Cellular Tissue to Include: Eczema; Psoriasis; Impetigo Contagiosa; Verrucae (Warts); Scabies Herpes (Simple/Zoster); Furuncle, Carbuncle; Furunculosis; Dermatophytosis, and Dermatitis
54	Venereal Diseases

PATIENT CLASS DESCRIPTIONS

<u>PATIENT CLASS</u>	<u>DESCRIPTION</u>
55	Cardiac Conditions to Include: Arrhythmias; Congestive Heart Failure; Bacterial Endocarditis; Pericarditis; Acute Pulmonary Edema; Coronary Heart Disease (Myocardial Infarct and Angina Pectoris); Rheumatic Heart Disease; Rheumatic Fever, and Hypertension
56	Acute Respiratory Infections to Include: Pneumonia; Pleurisy; Influenza; Bronchitis, Acute/Chronic
57	Disease of Nose and Throat to Include: Laryngitis; Pharyngitis; Nasopharyngitis; Tonsillitis; Peritonsillar Abscess; Strep Throat
58	Diseases of the Sinuses and Nose to Include: Sinusitis, Acute; Sinusitis, Chronic; Deviated Septum; Polyps, and Epistaxis
59	Other Pulmonary Disorders to Include: Emphysema; Bronchiectasis; Empyema; Lung Abscess, and Bronchial Asthma
60	Metabolic and Nutritional Diseases
61	Intestinal Diseases and Conditions to Include: Gastritis, Gastroenteritis, and Enteritis
62	Peptic Ulcer
63	FUO
64	Blood Dyscrasias
65	Poisoning: Food, Drug, Alcohol (Acute), and Gas
66	Exposure to Extreme Temperatures to Include: Heatstroke, Heat Exhaustion, Heat Cramps, and Frost Bite
67	Acute allergic reactions, including insect and reptile bites
68	All Other Diagnoses and Conditions
69	Contagious Viral Diseases: Hepatitis; Infectious Mononucleosis; Meningitis, Aseptic and Meningitis, and Meningococcal
70	Malaria

PATIENT CLASS DESCRIPTIONS

<u>PATIENT CLASS</u>	<u>DESCRIPTION</u>
71	All Other Viral Diseases to Include: Poliomyelitis, Smallpox, Yellow Fever, Rabies, Psittacosis, Trachoma, Measles, Chicken Pox, and Rubella, Mumps, Whooping Cough
72	All Bacterial Diseases to Include: Hansen's Disease, Typhoid, Cholera, Plague, Brucellosis, Bacillary Dysentery, and Tetanus; Protozoan Infections (Amebic Dysentery), and Rickettsial Infection (Typhus)
73	Psychosis
74	Psychiatric Conditions Except Psychosis to Include: Anxiety Reactions; Situational Maladjustment, Character Disorders; and Drug Abuse
75	Neurological Problems to Include: Paraplegia, Quadraplegia, Epilepsy, Migraine, Hemiplegia, Encephalitis, Headache, Multiple Sclerosis, Myasthenia Gravis, and Parkinson's Disease

APPENDIX B
Proportional Distribution of Casualties
Among Patient Classes

**PROPORTIONAL DISTRIBUTION OF CASUALTIES
AMONG PATIENT CLASSES**

<u>Patient Class*</u>	<u>Percent in Class</u>	
	<u>Inpatients</u>	<u>Outpatients</u>
1	.15	
2	.02	
3	1.24	
4	.42	
5	.23	
6	.90	
7	.37	
8	.37	
9	.00	
10	.49	
11	1.15	
12	1.48	
13	3.46	
14	.16	
15	.64	
16	.21	
17	.49	
18	.27	1.80
19	.41	
20	1.07	1.00
21	.16	
22	.38	
23	.38	
24	1.42	
25	2.50	
26	10.01	

*See Appendix A for Patient Class Descriptions

**PROPORTIONAL DISTRIBUTION OF CASUALTIES
AMONG PATIENT CLASSES**

<u>Patient Class*</u>	<u>Percent in Class</u>	
	<u>Inpatients</u>	<u>Outpatients</u>
27	.48	
28	.48	
29	.53	
30	1.23	
31	5.34	
32	5.34	
33	3.98	
34	.03	
35	1.76	
36	5.78	
37	.64	
38	1.18	
39	3.62	
40	.19	
41	.69	
42	.57	
43	1.10	
44	.01	
45	1.38	.10
46	2.73	27.30
47	.47	.70
48	2.24	.70
49	1.42	
50	.26	12.00
51	.04	
52	.31	2.40

*See Appendix A for Patient Class Descriptions.

**PROPORTIONAL DISTRIBUTION OF CASUALTIES
AMONG PATIENT CLASSES**

<u>Patient Class*</u>	<u>Percent in Class</u>	
	<u>Inpatients</u>	<u>Outpatients</u>
53	4.08	7.40
54	.32	1.70
55	.93	.40
56	1.47	6.30
57	.84	14.20
58	.15	5.10
59	.41	1.10
60	.26	
61	2.89	4.80
62	.30	
63	3.66	1.10
64	.18	
65	.25	
66	1.35	
67	.00	1.50
68	3.06	5.40
69	.58	
70	3.13	
71	.07	.60
72	1.74	.60
73	.26	
74	3.01	3.80
75	.88	

*See Appendix A for Patient Class Descriptions

APPENDIX C
MARINE CORPS STUDY

Medical/Surgical Work Units and

Designated Treaters

(Baseline Case)

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
1	Psychological first aid	3	11 10 23 6	Clinical Psychologist Psychiatrist Neuropsychiatric Technician Physicians Assistant
2	Routine DX/TX, e.g., URI, Sore throats, etc.	10	6 4 3 1 17	Physicians Assistant Shock & Surgical Corpsman General Medical Practitioner General Surgeon Internist
3	Triage	4	1 19 20 3	General Surgeon Orthopedic Surgeon Thoracic Surgeon General Medical Practitioner
5	Clinical records prepared by professional staff	10	1 19 20 22	General Surgeon Orthopedic Surgeon Thoracic Surgeon Neurosurgeon
6	Litter Hauling	3	15	Litter Team (4 men each)
7	Dental Screen	15	9 29 6 3	Oral Surgeon Dental Technician Physicians Assistant General Medical Practitioner
8	Dispensing non-injection-type medications	5	28 2 4	Pharmacy Technician Ward Nurse (Med/Surgical) Shock and Surgical Corpsman
9	Administration of injectible medications	1	4 6 2 1	Shock and Surgical Corpsman Physicians Assistant Ward Nurse (Med/Surgical) General Surgeon
10	Splints	6	6 4 21 3	Physicians Assistant Shock and Surgical Corpsman Cast Room Technician General Medical Practitioner
11	Dressings	6	6 4 3 1	Physicians Assistant Shock and Surgical Corpsman General Medical Practitioner General Surgeon
12	Clamp Ligate	2	6 3 1 9 20	Physicians Assistant General Medical Practitioner General Surgeon Oral Surgeon Thoracic Surgeon

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS. LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
13	IV Fluids	6	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			9	Oral Surgeon
			2	Ward Nurse (Med/Surgical)
14	Surgical insert of an intra-cath.	12	1	General Surgeon
			3	General Medical Practitioner
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
			9	Oral Surgeon
15	Surgical procedure to open an airway and/or endotracheal tube insertion	15	1	General Surgeon
			6	Physicians Assistant
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
16	Seal Sucking Chest Wound	2	1	General Surgeon
			6	Physicians Assistant
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
17	Perform mouth-to-mouth resuscitation. Mechanical resuscitation (pulmotor) where equipment is available.	2	4	Shock and Surgical Corpsman
			6	Physicians Assistant
			3	General Medical Practitioner
			9	Oral Surgeon
18	Wash, clean, dress minor contusions and abrasions	5	4	Shock and Surgical Corpsman
			6	Physicians Assistant
			29	Dental Technician
			2	Ward Nurse (Med/Surgical)
19	Surgical drain minor abscess	10	1	General Surgeon
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
			6	Physicians Assistant
20	Treat heat and cold injuries	15	4	Shock and Surgical Corpsman
			6	Physicians Assistant
			1	General Surgeon
22	Cast Fx	20	21	Cast Room Technician
			19	Orthopedic Surgeon
23	Antidote for acute allergic reactions, including insect and reptile bites	5	3	General Medical Practitioner
			6	Physicians Assistant
			4	Shock and Surgical Corpsman

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
24	Thorocentesis	10	1	General Surgeon
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
			3	General Medical Practitioner
25	Insert Chest Tube and Intercostal N Block	5	20	Thoracic Surgeon
			1	General Surgeon
			19	Orthopedic Surgeon
26	Local Anesthesia	5	18	O.R. Nurse
			7	Operating Room Technician
			12	Nurse Anesthetist
			3	General Medical Practitioner
27	Insert Foley Cath.	5	2	Ward Nurse (Med/Surgical)
			6	Physicians Assistant
			3	General Medical Practitioner
			17	Internist
			1	General Surgeon
			19	Orthopedic Surgeon
28	Insert N/G Tube	10	2	Ward Nurse (Med/Surgical)
			6	Physicians Assistant
			3	General Medical Practitioner
			17	Internist
			1	General Surgeon
			19	Orthopedic Surgeon
29	Debridement (Minor Wounds)	35	3	General Medical Practitioner
			1	General Surgeon
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
31	Simple Lab studies, e.g., urine, Hb, WBC	12	13	Laboratory Technician
32	Dx Malaria	10	13	Laboratory Technician
33	X-Ray	25	16	X-Ray Technician
34	EKG	25	25	Cardiopulmonary Technician
			4	Shock and Surgical Corpsman
			2	Ward Nurse (Med/Surgical)
35	Eye care including eye surgery, nursing care, etc.	90	14	Ophthalmologist
			1	General Surgeon
			19	Orthopedic Surgeon
36	Emergency psychiatric care	35	10	Psychiatrist
			11	Clinical Psychologist
			23	Neuropsychiatric Technician

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
37	Daily rounds on ward patients	45	3	General Medical Practitioner
			17	Internist
			1	General Surgeon
			20	Thoracic Surgeon
38	Consultation	35	1	General Surgeon
			17	Internist
			19	Orthopedic Surgeon
			20	Thoracic Surgeon
39	Surgical debridement and stabilization or repair of face, neck or head wounds	60	9	Oral Surgeon
			20	Thoracic Surgeon
			1	General Surgeon
			22	Neurosurgeon
40	Dental Care	40	9	Oral Surgeon
			29	Dental Technician
			6	Physicians Assistant
41	Major surgery or debridement	120	1	General Surgeon
			20	Thoracic Surgeon
44	Treatment requiring Internist	45	17	Internist
			3	General Medical Practitioner
			1	General Surgeon
			19	Orthopedic Surgeon
45	Extensive Lab Exams	20	13	Laboratory Technician
46	Orthopedic reduction, repair and stabilization	100	19	Orthopedic Surgeon
			1	General Surgeon
			20	Thoracic Surgeon
47	Neurological stabilization, debridement/repair	120	22	Neurosurgeon
			1	General Surgeon
			19	Orthopedic Surgeon
48	Thoracic surgery, debridement and stabilization	120	20	Thoracic Surgeon
			1	General Surgeon
			19	Orthopedic Surgeon
49	Gastric Lavage	25	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			3	General Medical Practitioner

APPENDIX D
MARINE CORPS STUDY

Medical Personnel (Treaters)
and their assigned
Medical/Surgical Work Units
(Baseline Case)

**MARINE CORPS STUDY
(BASELINE CASE)**

TREATER		WORK UNITS PERFORMED	
CODE	DESCRIPTION	CODE	DESCRIPTION
1	General Surgeon	3	Triage (1)*
		5	Records (1)
		14	Intra-Cath. (1)
		15	Surgical Airway (1)
		16	Sucking Chest Wound (1)
		19	Minor Abscess (1)
		24	Thorocentesis (1)
		38	Consultation (1)
		41	Major Surgery/Debridement (1)
		25	Chest Tube Insertion (2)
		29	Minor Wound Debridement (2)
		35	Emergency Eye Care (2)
		46	Orthopedic Reduction (2)
		47	Neurological Stabilization (2)
		48	Thoracic Surgery (2)
		12	Clamp Ligate (3)
		20	Heat/Cold Injuries (3)
		37	Ward Rounds (3)
		39	Face/Neck/Head Wounds (3)
		44	Internal Medicine (3)
		2	Routine DX/TX (4)
		9	Injections (4)
		11	Dressings (4)
		27	Foley Cath. (5)
		28	N/G Tube (5)
2	Ward Nurse (Med/Surg)	27	Foley Cath. (1)
		28	N/G Tube (1)
		8	Non-Injection Medications (2)
		9	Injectible Medications (3)
		34	EKG (3)
		13	IV Fluids (4)
		18	Minor Contusions (4)
3	General Medical Practitioner	23	Acute Allergic Reactions (1)
		29	Debridement (Minor Wounds) (1)
		37	Ward Rounds (1)
		12	Clamp Ligate (2)
		14	Intra-Cath. (2)
		44	Internal Medicine (2)
		2	Routine DX/TX (3)
		11	Dressings (3)

*Numbers in parentheses indicate the order in which a treater is selected to perform a particular work unit, e.g., the General Surgeon is first choice for triage, records, etc; he is second choice for chest tube insertion, minor wound debridement, etc.

TREATER	
CODE	DESCRIPTION
3	General Medical Practitioner (Cont'd)

4	Shock and Surgical Corpsman
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5	Surgical Ward Corpsman
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6	Physicians Assistant
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7	O.R. Technician
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WORK UNITS PERFORMED	
CODE	DESCRIPTION

17	Resuscitation (3)
27	Foley Cath. (3)
28	N/G Tube (3)
49	Gastric Lavage (3)
3	Triage (4)
7	Dental Screen (4)
10	Splints (4)
24	Thorocentesis (4)
26	Local Anesthesia (4)
9	Injectible Medications (1)
17	Resuscitation (1)
18	Minor Contusions (1)
20	Heat/Cold Injuries (1)
2	Routine DX/TX (2)
10	Splints (2)
11	Dressings (2)
13	IV Fluids (2)
34	EKG (2)
49	Gastric Lavage (2)
8	Non-Injection Medications (3)
23	Acute Allergic Reactions (3)

None (Assists in Surgery.)

2	Routine DX/TX (1)
10	Splints (1)
11	Dressings (1)
12	Clamp Ligate (1)
13	IV Fluids (1)
49	Gastric Lavage (1)
9	Injectible Medications (2)
15	Airway (2)
16	Sucking Chest Wound (2)
17	Resuscitation (2)
18	Minor Contusions (2)
20	Heat/Cold Injuries (2)
23	Acute Allergic Reactions (2)
27	Foley Cath. (2)
28	N/G Tube (2)
7	Dental Screen (3)
40	Dental Care (3)
1	Psychological First Aid (4)
19	Minor Abscess (4)

26	Local Anesthesia (2)
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Note: O.R. Technician Assists in Surgery.

TREATER		WORK UNITS PERFORMED	
CODE	DESCRIPTION	CODE	DESCRIPTION
8	Anesthesiologist	None.	Works with Surgeons.
9	Oral Surgeon	7	Dental Screen (1)
		39	Face/Neck/Head Wounds (1)
		40	Dental Care (1)
		13	IV Fluids (3)
		12	Clamp Ligate (4)
		14	Intra-Cath. (4)
		17	Resuscitation (4)
10	Psychiatrist	36	Emergency Psychiatric Care (1)
		1	Psychological First Aid (2)
11	Clinical Psychologist	1	Psychological First Aid (1)
		36	Emergency Psychiatric Care (2)
12	Nurse Anesthetist	26	Local Anesthesia (3)
			(Note: Works with Surgeons.)
13	Laboratory Technician	31	Simple Lab. Studies (1)
		32	DX Malaria (1)
		45	Extensive Lab. Exams (1)
14	Ophthalmologist	35	Emergency Eye Care (1)
15	Litter Team	6	Litter Hauling (1)
16	X-Ray Technician	33	X-Ray (1)
17	Internist	44	Internal Medicine (1)
		37	Ward Rounds (2)
		38	Consultation (2)
		27	Foley Cath. (4)
		28	N/G Tube (4)
		2	Routine DX/TX (5)
18	O.R. Nurse	26	Local Anesthesia (1)
			(Note: Works with Surgeons.)
19	Orthopedic Surgeon	46	Orthopedic Reduction (1)
		3	Triage (2)
		5	Records (2)
		22	Cast FX (2)
		19	Minor Abscess (3)
		24	Thorocentesis (3)
		25	Chest Tube Insertion (3)
		35	Emergency Eye Care (3)
		38	Consultation (3)

TREATER		WORK UNITS PERFORMED	
CODE	DESCRIPTION	CODE	DESCRIPTION
19	Orthopedic Surgeon (continued)	47	Neurological Stabilization (3)
		48	Thoracic Surgery (3)
		14	Intra-Cath. (4)
		15	Airway (4)
		16	Sucking Chest Wound (4)
		29	Debridement (Minor Wounds) (4)
		44	Internal Medicine (4)
		27	Foley Cath. (6)
		28	N/G Tube (6)
20	Thoracic Surgeon	25	Chest Tube Insertion (1)
		48	Thoracic Surgery (1)
		19	Minor Abscess (2)
		24	Thorocentesis (2)
		39	Face/Neck/Head Wounds (2)
		41	Major Surgery/Debridement (2)
		3	Triage (3)
		5	Records (3)
		14	Intra-Cath (3)
		15	Airway (3)
		16	Sucking Chest Wound (3)
		29	Debridement (Minor Wounds) (3)
		46	Orthopedic Reduction (3)
		37	Ward Rounds (4)
		38	Consultation (4)
		12	Clamp Ligate (5)
21	Cast Room Technician	22	Cast FX (1)
		10	Splints (3)
22	Neurosurgeon	47	Neurological Stabilization (1)
		5	Records (4)
		39	Face/Neck/Head Wounds (4)
23	Neuropsychiatric Technician	1	Psychological First Aid (3)
		36	Emergency Psychiatric Care (3)
24	Triage Specialist	3	Triage (5) (Note: Only Treater at BAS)
25	Cardiopulmonary Technician	34	EKG (1)
27	Dermatology Technician		None
28	Pharmacy Technician	8	Non-Injection Medications (1)
29	Dental Technician	7	Dental Screen (2)
		40	Dental Care (2)
		18	Minor Contusions (3)

APPENDIX E

MARINE CORPS STUDY

Medical/Surgical Work Units and
Designated Treaters

(Modification 1 to relieve work load of General Surgeons
and Orthopedic Surgeons at MEDCO level)

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
1	Psychological first aid	5	11	Clinical Psychologist
			10	Psychiatrist
			23	Neuropsychiatric Technician
			6	Physician Assistant
2	Routine DX/TX, e.g., URI, Sore throats, etc.	10	6	Physician Assistant
			4	Shock & Surgical Corpsman
			3	General Medical Practitioner
3	Triage	4	1	General Surgeon
			19	Orthopedic Surgeon
			20	Thoracic Surgeon
			3	General Medical Practitioner
5	Clinical records prepared	10	4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
6	Litter Hauling	3	15	Litter Team (4 men each)
7	Dental Screen	15	9	Oral Surgeon
			29	Dental Technician
			6	Physicians Assistant
			3	General Medical Practitioner
8	Dispensing non-injection-type medications	5	28	Pharmacy Technician
			2	Ward Nurse (Med/Surgical)
			4	Shock and Surgical Corpsman
9	Administration of injectible medications	1	4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
			6	Physicians Assistant
			2	Ward Nurse (Med/Surgical)
10	Splints	6	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			21	Cast Room Technician
			3	General Medical Practitioner
11	Dressings	6	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
			3	General Medical Practitioner
12	Clamp Ligate	2	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			3	General Medical Practitioner
13	IV Fluids	6	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			9	Oral Surgeon
			2	Ward Nurse (Med/Surgical)

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
14	Surgical insert of an intra-cath	12	3	General Medical Practitioner
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
15	Surgical procedure to open airway and/or endotracheal tube insertion	15	1	General Surgeon
			6	Physicians Assistant
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
16	Seal Sucking Chest Wound	2	1	General Surgeon
			6	Physicians Assistant
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
17	Perform mouth-to-mouth resuscitation. Mechanical resuscitation (pulmotor) where equipment is available.	2	4	Shock and Surgical Corpsman
			6	Physicians Assistant
			3	General Medical Practitioner
			9	Oral Surgeon
18	Wash, clean, dress minor contusions and abrasions	5	4	Shock and Surgical Corpsman
			6	Physicians Assistant
			29	Dental Technician
			2	Ward Nurse (Med/Surgical)
19	Surgical drain minor abscess	10	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
20	Treat heat and cold injuries	15	4	Shock and Surgical Corpsman
			6	Physicians Assistant
22	Cast Fx	20	21	Cast Room Technician
			19	Orthopedic Surgeon
23	Antidote for acute allergic reactions, including insect and reptile bites	5	3	General Medical Practitioner
			6	Physicians Assistant
			4	Shock and Surgical Corpsman
24	Thorocentesis	10	1	General Surgeon
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
			3	General Medical Practitioner
25	Insert Chest Tube and Intercostal N Block	5	20	Thoracic Surgeon
			1	General Surgeon
			19	Orthopedic Surgeon
26	Local Anesthesia	5	18	O.R. Nurse
			7	Operating Room Technician
			12	Nurse Anesthetist
			3	General Medical Practitioner

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
27	Insert Foley Cath.	5	2	Ward Nurse (Med/Surgical)
			6	Physicians Assistant
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
			3	General Medical Practitioner
28	Insert N/G Tube	10	2	Ward Nurse (Med/Surgical)
			6	Physicians Assistant
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
			3	General Medical Practitioner
29	Debridement (Minor Wounds)	35	3	General Medical Practitioner
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
31	Simple Lab studies, e.g., urine, Hb, WBC	12	13	Laboratory Technician
32	Dx Malaria	10	13	Laboratory Technician
33	X-Ray	25	16	X-Ray Technician
34	EKG	25	25	Cardiopulmonary Technician
			4	Shock and Surgical Corpsman
			2	Ward Nurse (Med/Surgical)
35	Emergency eye care	90	14	Ophthalmologist
			4	Shock and Surgical Corpsman
			5	Surgical Ward Corpsman
36	Emergency psychiatric care	35	10	Psychiatrist
			11	Clinical Psychologist
			23	Neuropsychiatric Technician
37	Daily rounds on ward patients	45	3	General Medical Practitioner
			17	Internist
			1	General Surgeon
			20	Thoracic Surgeon
38	Consultation	35	1	General Surgeon
			17	Internist
			19	Orthopedic Surgeon
			20	Thoracic Surgeon
39	Surgical debridement and stabilization or repair of face, neck or head wounds	60	9	Oral Surgeon
			20	Thoracic Surgeon
			1	General Surgeon
			22	Neurosurgeon
			19	Orthopedic Surgeon

WORK UNITS		PERFORMANCE TIME (MINUTES)	DESIGNATED TREATERS, LISTED IN PREFERRED ORDER	
CODE	DESCRIPTION		CODE	DESCRIPTION
40	Dental Care	40	9	Oral Surgeon
			29	Dental Technician
			6	Physicians Assistant
41	Major surgery or debridement	120	1	General Surgeon
			20	Thoracic Surgeon
			19	Orthopedic Surgeon
44	Treatment requiring Internist	45	17	Internist
			3	General Medical Practitioner
			1	General Surgeon
			19	Orthopedic Surgeon
45	Extensive Lab Exams	20	13	Laboratory Technician
46	Orthopedic reduction, repair and stabilization	100	19	Orthopedic Surgeon
			1	General Surgeon
			20	Thoracic Surgeon
47	Neurological stabilization, debridement/repair	120	22	Neurosurgeon
			1	General Surgeon
			19	Orthopedic Surgeon
48	Thoracic Surgery, debridement and stabilization	120	20	Thoracic Surgeon
			1	General Surgeon
			19	Orthopedic Surgeon
49	Gastric Lavage	25	6	Physicians Assistant
			4	Shock and Surgical Corpsman
			3	General Medical Practitioner

APPENDIX F
MARINE CORPS STUDY

Medical Personnel (Treaters)
and their assigned
Medical/Surgical Work Units

(Modification 1 to relieve work load of General Surgeons
and Orthopedic Surgeons at MEDCO level)

MARINE CORPS STUDY
(Modification 1)

<u>TREATER</u>		<u>WORK UNITS PERFORMED</u>	
<u>CODE</u>	<u>DESCRIPTION</u>	<u>CODE</u>	<u>DESCRIPTION</u>
1	General Surgeon	3	Triage (1)*
		15	Surgical Airway (1)
		16	Sucking Chest Wound (1)
		24	Thorocentesis (1)
		38	Consultation (1)
		41	Major Surgery/Debridement (1)
		25	Chest Tube Insertion (2)
		46	Orthopedic Reduction (2)
		47	Neurological Stabilization (2)
		48	Thoracic Surgery (2)
		37	Ward Rounds (3)
		39	Face/Neck/Head Wounds (3)
		44	Internal Medicine (3)
2	Ward Nurse (Med/Surg)	27	Foley Cath. (1)
		28	N/G Tube (1)
		8	Non-Injection Medications (2)
		34	EKG (3)
		9	Injectible Medications (4)
		13	IV Fluids (4)
		18	Minor Contusions (4)
3	General Medical Practitioner	14	Intra-Cath (1)
		23	Acute Allergic Reactions (1)
		29	Debridement (Minor Wounds) (1)
		37	Ward Rounds (1)
		44	Internal Medicine (2)
		2	Routine DX/TX (3)
		12	Clamp Ligate (3)
		17	Resuscitation (3)
		49	Gastric Lavage (3)
		3	Triage (4)
		7	Dental Screen (4)
		10	Splints (4)
		11	Dressings (4)
		24	Thorocentesis (4)
		26	Local Anesthesia (4)
		27	Foley Cath. (5)
		28	N/G Tube (5)

*Numbers in parentheses indicate the order in which a treater is selected to perform a particular work unit, e.g., the General Surgeon is first choice for Triage, etc.; he is second choice for chest tube insertion, etc.

CODE	TREATER DESCRIPTION
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4	Shock and Surgical Corpsman
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5	Surgical Ward Corpsman
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6	Physicians Assistant
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CODE	WORK UNITS PERFORMED DESCRIPTION
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5	Clinical Records (1)
9	Injectible Medications (1)
14	Intra-Cath. (1)
17	Resuscitation (1)
18	Minor Contusions (1)
20	Heat/Cold Injuries (1)
2	Routine DX/TX (2)
10	Splints (2)
11	Dressings (2)
12	Clamp Ligate (2)
13	IV Fluids (2)
19	Minor Abscess (2)
29	Debridement (Minor Wounds) (2)
34	EKG (2)
35	Emergency Eye Care (2)
49	Gastric Lavage (2)
6	Non-Injection Medications (3)
23	Acute Allergic Reactions (3)
27	Foley Cath. (3)
28	N/G Tube (3)

5	Clinical Records (2)
9	Injectible Medications (2)
14	Intra-Cath. (2)
11	Dressings (3)
19	Minor Abscess (3)
29	Debridement (Minor Wounds) (3)
35	Emergency Eye Care (3)
27	Foley Cath. (4)
28	N/G Tube (4)

2	Routine DX/TX (1)
10	Splints (1)
11	Dressings (1)
12	Clamp Ligate (1)
13	IV Fluids (1)
19	Minor Abscess (1)
49	Gastric Lavage (1)
15	Airway (2)
16	Sucking Chest Wound (2)
17	Resuscitation (2)
18	Minor Contusions (2)
20	Heat/Cold Injuries (2)
23	Acute Allergic Reactions (2)
27	Foley Cath. (2)
28	N/G Tube (2)
7	Dental Screen (3)
9	Injectible Medications (3)
40	Dental Care (3)
1	Psychological First Aid (4)

<u>CODE</u>	<u>TREATER DESCRIPTION</u>
7	O.R. Technician
8	Anesthesiologist
9	Oral Surgeon
10	Psychiatrist
11	Clinical Psychologist
12	Nurse Anesthetist
13	Laboratory Technician
14	Ophthalmologist
15	Litter Team
16	X-Ray Technician
17	Internist
18	O.R. Nurse
19	Orthopedic Surgeon

<u>CODE</u>	<u>WORK UNITS PERFORMED DESCRIPTION</u>
26	Local Anesthesia (2)
Note: O.R. Technician assists in Surgery.	
None.	Works with Surgeons.
7	Dental Screen (1)
39	Face/Neck/Head Wounds (1)
40	Dental Care (1)
13	IV Fluids (3)
17	Resuscitation (4)
36	Emergency Psychiatric Care (1)
1	Psychological First Aid (2)
1	Psychological First Aid (1)
36	Emergency Psychiatric Care (2)
26	Local Anesthesia (3)
	(Note: Works with Surgeons.)
31	Simple Lab. Studies (1)
32	DX Malaria (1)
45	Extensive Lab. Exams (1)
35	Emergency Eye Care (1)
6	Litter Hauling (1)
33	X-Ray (1)
44	Internal Medicine (1)
37	Ward Rounds (2)
38	Consultation (2)
26	Local Anesthesia (1)
	(Note: Works with Surgeons.)
46	Orthopedic Reduction (1)
3	Triage (2)
22	Cast FX (2)
24	Thorocentesis (3)
25	Chest Tube Insertion (3)
38	Consultation (3)
41	Major Surgery/Debridement (3)
47	Neurological Stabilization (3)
48	Thoracic Surgery (3)
15	Airway (4)
16	Sucking Chest Wound (4)
44	Internal Medicine (4)
39	Face/Neck/Head Wounds (5)

<u>TREATER</u>	
<u>CODE</u>	<u>DESCRIPTION</u>
20	Thoracic Surgeon
21	Cast Room Technician
22	Neurosurgeon
23	Neuropsychiatric Technician
24	Triage Specialist
25	Cardiopulmonary Technician
27	Dermatology Technician
28	Pharmacy Technician
29	Dental Technician

<u>WORK UNITS PERFORMED</u>	
<u>CODE</u>	<u>DESCRIPTION</u>
25	Chest Tube Insertion (1)
48	Thoracic Surgery (1)
24	Thorocentesis (2)
39	Face/Neck/Head Wounds (2)
41	Major Surgery/Debridement (2)
3	Triage (3)
15	Airway (3)
16	Sucking Chest Wound (3)
46	Orthopedic Reduction (3)
37	Ward Rounds (4)
38	Consultation (4)
22	Cast FX (1)
10	Splints (3)
47	Neurological Stabilization (1)
39	Face/Neck/Head Wounds (4)
1	Psychological First Aid (3)
36	Emergency Psychiatric Care (3)
3	Triage (5) (Note: Only Treater at BAS.)
34	EKG (1)
	None
8	Non-Injection Medications (1)
7	Dental Screen (2)
40	Dental Care (2)
18	Minor Contusions (3)